

Species

To Cite:

Pandey R, Jha PK, Paudel AS. Seasonal variation of bird diversity in Chokchisapani Community Forest, Tanahu District, Nepal. *Species* 2024; 25: e22s1663
doi: <https://doi.org/10.54905/disssi.v25i75.e22s1663>

Author Affiliation:

Tri-Chandra Multiple Campus, Department of Zoology, Tribhuvan University, Kathmandu, Nepal

*Corresponding Author

Tri-Chandra Multiple Campus, Department of Zoology, Tribhuvan University, Kathmandu, Nepal
Email: aayushasp818@gmail.com

Peer-Review History

Received: 28 February 2024
Reviewed & Revised: 02/March/2024 to 04/May/2024
Accepted: 08 May 2024
Published: 15 May 2024

Peer-Review Model

External peer-review was done through double-blind method.

Species

pISSN 2319–5746; eISSN 2319–5754



© The Author(s) 2024. Open Access. This article is licensed under a [Creative Commons Attribution License 4.0 \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/), which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.

Seasonal variation of bird diversity in Chokchisapani Community Forest, Tanahu District, Nepal

Rabina Pandey, Praveen Kumar Jha, Aayusha Sharma Paudel*

ABSTRACT

Investigating the diversity of unprotected areas is fundamental in comprehensively understanding national bird diversity, as neglecting these smaller, often overlooked areas can lead to an incomplete portrayal of the nation's total avian population. To provide baseline information of bird diversity, abundance and richness a survey was undertaken in the Chokchisapani Community Forest in the autumn and winter months. Birds were assessed utilizing Point Count Method which revealed 59 species from 29 families and 11 orders. 24 species were recorded in the autumn season and 53 species of birds were identified in the winter season while 18 species were seen in both seasons. The diversity of species throughout two separate seasons was analyzed with the help of Shannon-Weiner Diversity Index. In comparison to the autumn season ($H=2.629$) ($E=0.827$), the winter season ($H=3.3$) ($E=0.831$) demonstrated greater bird diversity as well as evenness. Simpson's Diversity Index Showed that winter season ($SDI=0.12$) had lower dominance than autumn season ($SDI=0.11$). Unaware utilization of forest resources is a threat to the avian diversity of the area. Involvement of villagers in decision making and management practices will ensure a healthy forest ecosystem.

Keywords: Bird, Community Forest, Diversity, Season.

1. INTRODUCTION

More than 10,000 birds are found worldwide among them 892 species of birds found in Nepal so far. Amongst them, 42 species are placed in IUCN Red List of Threatened Species from which 10 are critically endangered, 8 are endangered and 24 are vulnerable in conservation status. Every year in Nepal more than 150 species of winter birds come from the Northern part of Russia, China, Mongolia, Europe, Korea, and Tibet (Jha, 2019). Around 50 species of passage migrant birds travel across Nepal to reach India, Pakistan, and Sri Lanka and 60 species of summer visitor birds come to Nepal whose habitat is Forest, Grassland, and Agricultural land (Jha, 2016).

A forest, managed for the benefit of community by the local authority is called a community forest. This forest is established to supply goods, food, source of income,

employment opportunity and environmental security to the houses and families in rural community (Graham et al., 2020). Forest birds rely on natural structures and morphology of the forest for their survival (Gumede et al., 2022). However, overgrazing, collecting unnecessary fodder, timber extraction and removal of fallen tree logs can cause short- and long-term damage to the birds that depend on it (Barzan et al., 2023). In this age and time, management of forest in a sustainable approach has become crucial for the protection of biodiversity (Hollie et al., 2020). There is an concerning issue of declining birds that requires forest for breeding due to regular extraction of forest resources. Birds being a natural indicator of forest ecosystem Stratford and Sekercioglu, (2015) makes them crucial in studying forest health as well (Ramírez-Soto et al., 2018).

Proper study of bird diversity of forest area also aids in better planning and management of the structure, type, growth and overall conservation of the forest (Leitão et al., 2022). Determining the seasonal diversity, relative abundance, and distribution of birds in Chokchisapani Community Forest was the primary goal of the study. The birds of this area has not been researched and remains unexplored, despite its potentially rich diversity. This study will help to provide baseline information about the diversity of avian species for future further studies and in the preparation of a comprehensive list of bird species in the forest area. Birds being highly sensitive and mobile, are most appropriate to study the impact of anthropogenic disturbance on biodiversity (Gibson et al., 2011). Hence this study will also provide insights on awareness, conservation and sustainable management of community forests.

2. MATERIALS AND METHODS

Study Area

Chokchisapani Community Forest lies 85 km eastward of Pokhara and 161 km to the west of the capital city Kathmandu (Figure 1). The forest is located in an area with a mid-temperate climate. June is the month with the highest average temperature, which is approximately 21.2 °C. However, the temperature can go as far below as 8.5°C during the month of January. The average temperature varies by 11.6°C. About 1,745mm of precipitation falls annually. Department of Hydrology and Meteorology (2022) states that November has the least amount of rainfall in the study area. The three main habitat types in the area are open spaces, shrublands, and forests. *Pinus roxburghii* (Salla), *Castanopsis indica* (Katush), *Ficus nemoralis* (Dudhilo), *Schima walichii* (Chilaune), *Alnus nepalensis* (Utis), and *Ficus religiosa* (Peepal) make up the majority of the vegetation in this area.

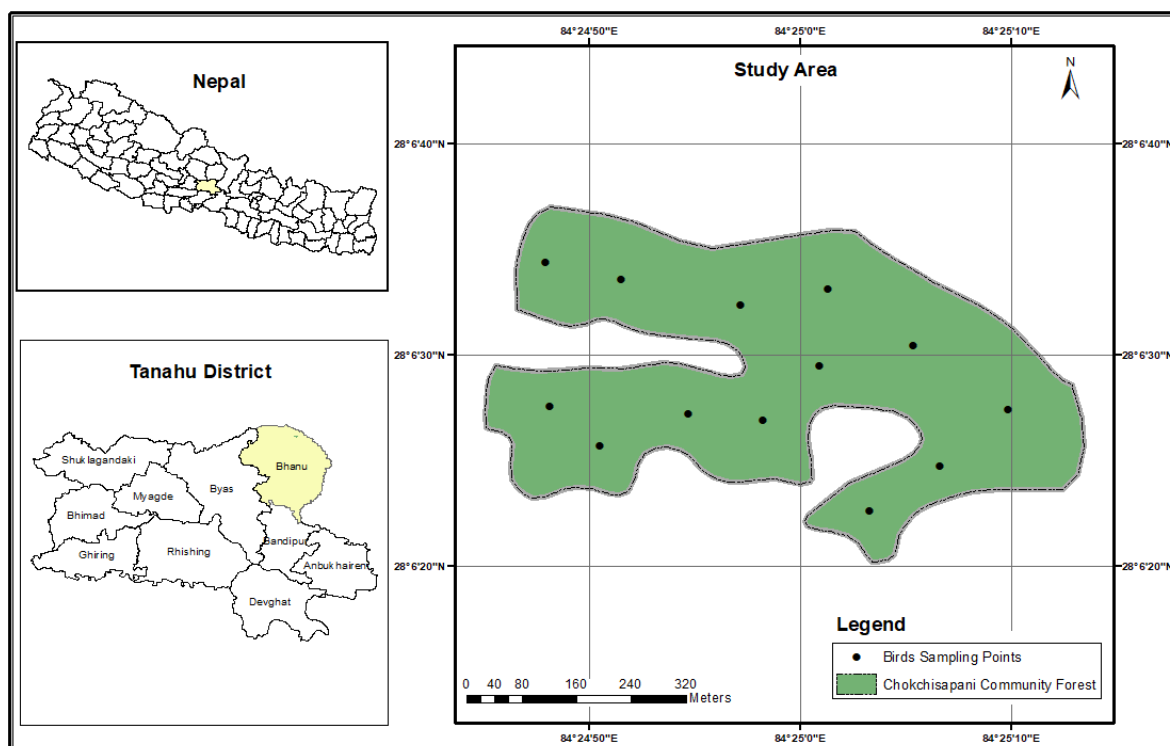


Figure-1: The Study Area of Chokchisapani Community Forest, Tanahu District

Figure 1 The Study Area of Chokchisapani Community Forest, Tanahu District

Methods

Birds were observed through point count method as described by (Sutherland, 2006). Altogether, 13 points count station with an interval of 200m between two points was established using the Geographic positioning system (GPS) and habitat types in the Study area. At each sampling point, the bird species were observed within a 50m radius for 20 minutes. The majority of birds are most active one or two hours after sunrise and before sunset (Jha, 2016). Bird observations were done for two hours each in the morning and evening during the autumn and winter season. A total of 8 days was spent in the field i.e., 4 days during the autumn season and 4 days in the winter season. Birds were recorded by direct observation utilizing RSPB 8×42 binocular for accurate recognition, Canon Powershot 5×40 HS to take photos of unidentified birds, “Birds of Nepal” Grimmett et al., (2016) for identification and self-prepared record sheet to note down birds observed during the survey. The survey was carried out within the month of 6-10 October 2022 (autumn) and 15-19 January 2023 (winter) to assess the seasonal variation of birds.

Data analysis

Species diversity was calculated in each season by using the Shannon-Wiener Diversity Index Shannon and Weaver, (1949) and Simpson’s Diversity Index (Simpson, 1949)

Shannon-Wiener Diversity states,

$$H = -\sum (P_i * \ln P_i)$$

Where,

H= Index of species diversity

P_i= The proportion of individuals in the ith species=n/N

n = Number of individuals of particular species

N = Number of all individuals of species present in the community

Also, for the relative Diversity of species, the following formula was used:

$$\text{Evenness} = \frac{H}{H_{\max}} \quad [H_{\max} = \ln S]$$

Where,

E= Relative diversity/Evenness

H = Calculated species diversity index

H_{max} = Proportion of maximum possible diversity

S = Number of species

Relative Abundance

$$RA = \frac{n}{N} * 100$$

Where,

n = Number of individuals species

N = Total number of birds

Simpson’s Index (D) states,

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

Where,

n = Number of all individual of a particular species in a community

N = Number of all individual of all the species present in the community

Simpson’s Diversity Index (SDI) states,

$$SDI = 1 - D$$

3. RESULTS

Seasonal Diversity of Birds of Chokchisapani Community Forest

Over the course of the two seasons of the study, 59 species of birds from 11 orders and 29 families were identified. The highest number of bird species, 41 to be exact, was recorded from the Passeriformes order, covering 18 families. Rest orders include: Apodiformes with 2 families and 2 species, Piciformes with 2 families and 3 species, Galliformes with 1 family and 3 species, Ciconiiformes with 1 family and 1 species, Falconiformes with 1 family and 1 species, Accipitiformes with 1 family and 1 species, Columbiformes with 1 family and

2 species, Psittaciformes with 1 family and 1 species, Cuculiformes with 1 family and 3 species, and Strigiformes with 1 family and 1 species. Numbers of birds species represented by orders and family are shown in (Figure 2 and Figure 3).

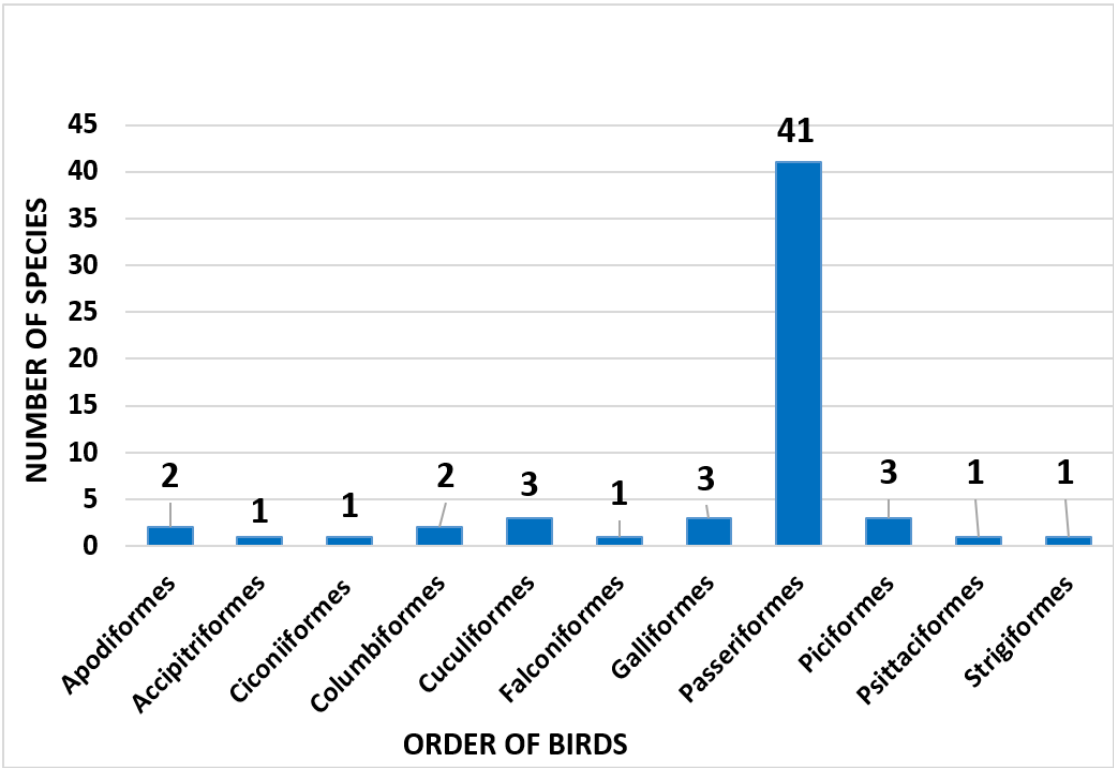


Figure 2 Order-wise distribution of Bird Species in the Study Area.

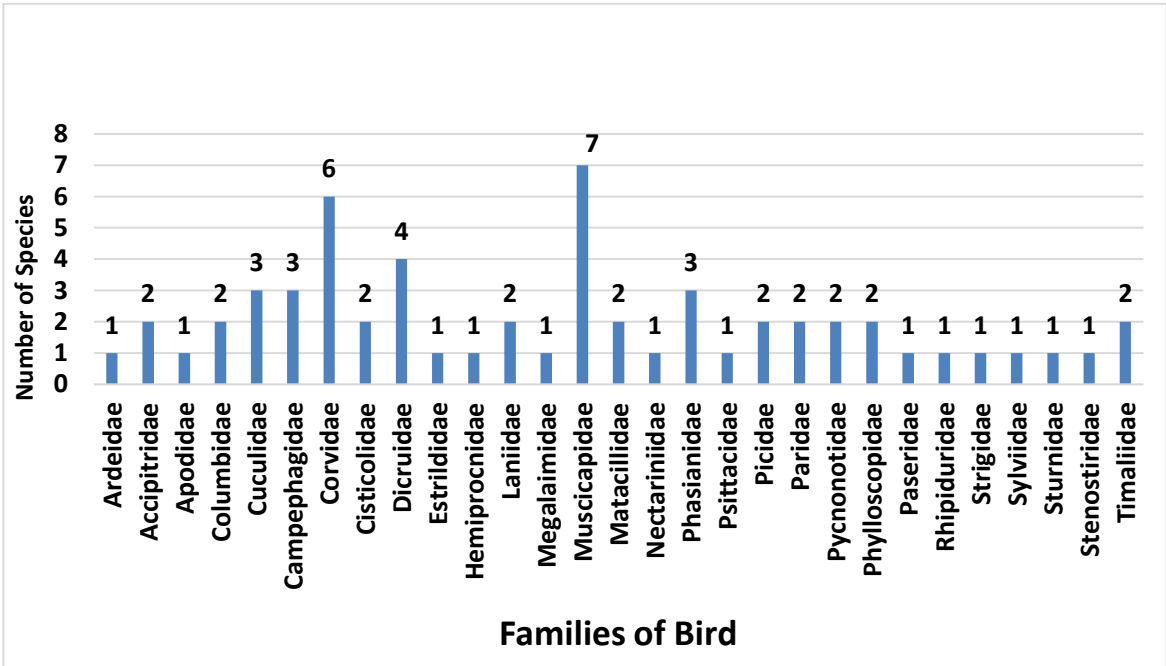


Figure 3 Family-wise distribution of Bird Species in Study Area.

Status of Migration in Birds

During the study period, out of 59 recorded species, 43 species belonged to residents, 4 species belonged to summer visitors and 12 species belonged to winter visitors (Figure 4).

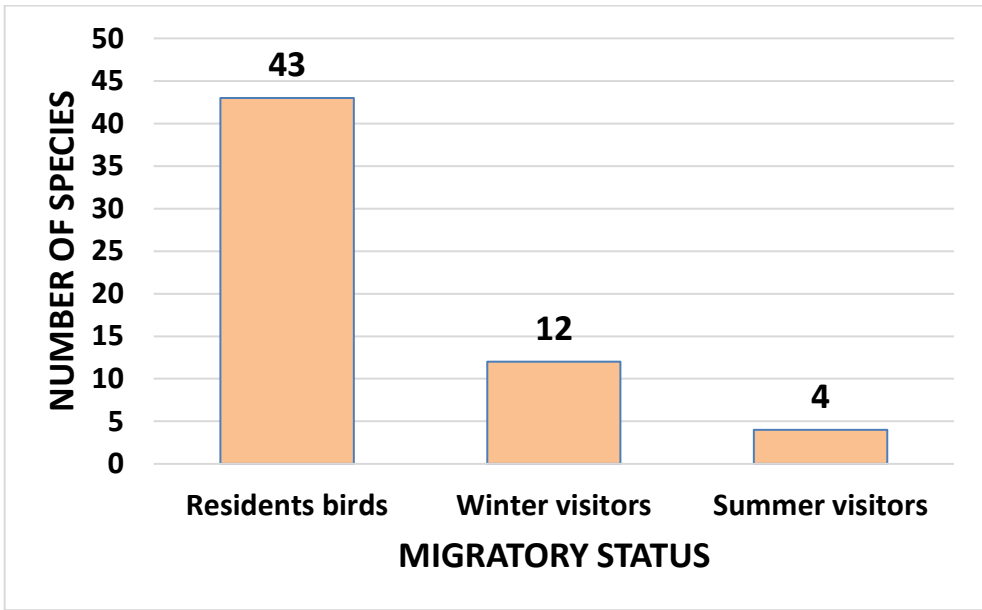


Figure 4 Migratory Status of Birds recorded in the Study Area.

Seasonal Status of Bird Species

The seasonal status of species varied during different seasons, such as autumn (n= 24) and winter (n= 53) (Figure 5). 18 species were found during both seasons. Thus, the diversity of birds was greater in the winter than in the autumn.

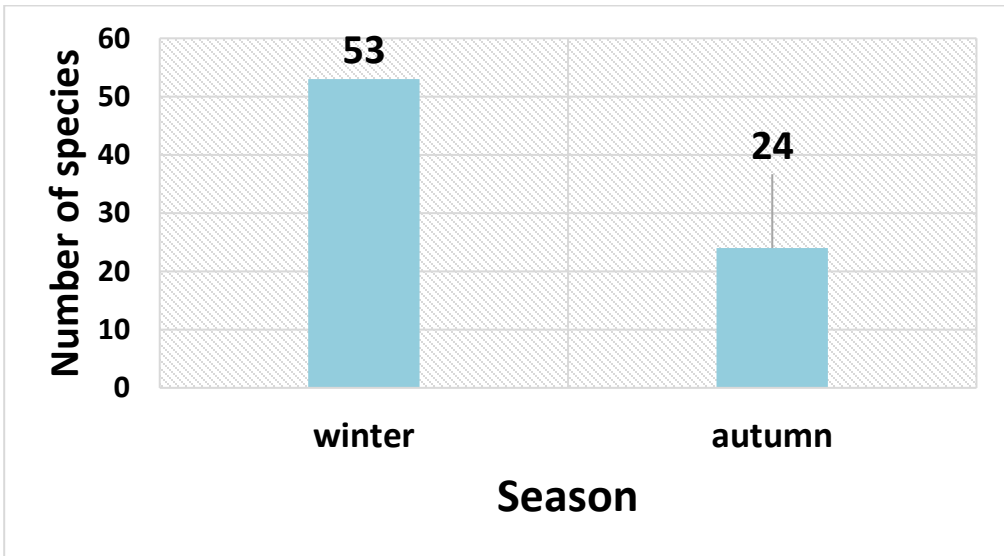


Figure 5 Seasonal Status of Birds recorded in the study area.

Relative abundance of the bird species

The relative abundance of the top five species (Figure 6) was highest in Ashy Woodpigeons followed by Grey Treepie, Grey-hooded Warbler, Yellow-bellied Fantail, and Red-vented Bulbul.

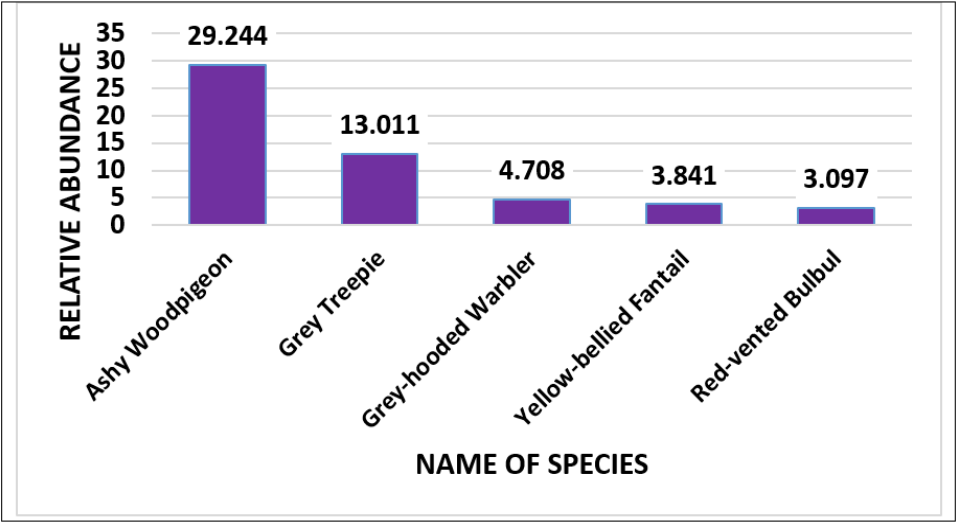


Figure 6 Relative Abundance of the Bird recorded in the Study Area.

Bird diversity over two seasons

The winter season ($H' = 3.3$) had a higher level of bird diversity than the autumn season ($H' = 2.629$), according to the Shannon-Weiner Diversity Index. Evenness Index also showed that birds were more evenly distributed during winter ($E = 0.831$) than autumn ($E = 0.827$).

Table 1 Shannon-Weiner Diversity Index for two seasons.

Season	S	N	$Pi(\frac{n}{N})$	Inpi	Pi(Inpi)	H	Hmax	Evenness
Autumn	24	231	0.985	-88.25	-2.629	2.629	3.178	0.827
Winter	53	576	0.985	-259.604	-3.3	3.3	3.97	0.831

Simpson’s Diversity Index Showed that winter season ($SDI = 0.12$) had lower dominance than autumn season ($SDI = 0.11$). Which means that when two individuals are selected randomly in winter season there is 12% chance that they belong to different species (Table 1). However, Simpson’s Index (D) was higher in Autumn Season ($D = 0.89$) in comparison to winter ($D = 0.88$). Which indicates the diversity of winter season is slightly higher than autumn season.

Table 2 Simpsons’s Diversity Index for two seasons.

Season	Species	N	D	SDI
Autumn	24	231	0.89	0.11
Winter	53	576	0.88	0.12

Forest resource utilization and management

During our research period we observed activities like collecting fodder, cutting grasses and grazing goats and cows by the villagers in the forest area (Table 2). Women in the village were seen collecting fallen trees, dried branches and other fire woods for cooking purpose. Through a small questionnaire among the villagers, it was revealed that more than half of the population of the villagers had migrated to city areas which might have led to zero to none proper management practices of the community forest. There was no limit and restrictions for the remaining villagers to utilize forest resources for their personal use as per the ward office however villagers had to issue a permit if the forest resource were to be utilized economically.

4. DISCUSSION

In the Chowkchisapani Community Forest, we found 59 different bird species, representing 29 families and 11 orders. Clearly, the winter season ($H=3.3$) had a higher value in the species diversity index than the autumn season ($H=2.629$). Additionally, evenness was more in the winter (0.831) than in the autumn (0.827). Simpson's Diversity Index Showed that winter season ($SDI=0.12$) had lower dominance than autumn season ($SDI=0.11$). However, the diversity of winter season ($D=0.88$) was slightly higher than autumn season ($D=0.89$). The reason could be the favorable climatic conditions for altitudinal migrants and long distant winter migrants. During winter season higher amount of migratory birds visit to avoid the unfavorable weather but in the summer season small amount of birds migrate for breeding purpose that's why the number of birds in winter is comparatively higher than the summer (Jha, 2019).

Furthermore, the maximum abundance of species was seen in shrub land followed by forest and open areas. This might be easy availability of food in the respective habitat. A similar pattern was observed where a higher number of species in shrub land were found which might be due to the nesting and protection opportunities based on the bird's habitat. Chowkchisapani community forest is surrounded by rural communities where majority of population depend on livestock and farming for a living. The resources of forest like timber, fodder, leaf litter, old logs, is utilized by the villagers. Grazing of goats and cows in the periphery is also occasionally seen. Neupane et al., (2022) in his study of forest management practice discusses that community forest can accommodate higher diversity of birds than protected forest, if it is properly managed. Minute and seemingly harmless factors like pruning and cutting grass of the forest areas can also cause disturbance but the same thing when done in a systematic manner could increase the diversity of forest by altering the vegetation it (Barzan et al., 2023).

White-rumped Spine tail and White-browed Scimitar Babbler were the two species in our study that have a National conservation status of Near Threatened. The population of these species in the forests are especially very sensitive to small changes in their habitat preference. In Chowkchisapani community forest, unaware utilization of forest resources by villagers might cause more harm than good. It is clear that for the sustainable management practice of community forest the extraction of resources must always be lower than the regeneration capacity of the forest (Bishnu et al., 2023). Involving the villagers in management practices by spreading awareness on the extraction of forest resources and its impact might be a beneficial and faster route to safeguard the forest's long-term health. Our study only focused on the bird diversity of winter and autumn season; we recommend a detailed study on avian diversity of all season to further improve management practices that benefits the bird diversity of the forest.

5. CONCLUSION

Chowkchisapani Community Forest has the potential to become a hotspot for birdwatchers and enthusiasts. In the present study, out of 59 species, 43 were residential birds, 4 were summer visitors and 12 were winter visitors. Ashy Woodpigeon, Grey Treepie, Yellow-bellied Fairy-fantail, Red-vented Bulbul, Grey-hooded Warbler and Russet Sparrow were most commonly seen species. The present study suggests that minute anthropogenic activities can cause damage to avian habitat therefore, sustainable forest management practices should be encouraged in order to further promote bird diversity in the area.

Acknowledgements

The authors would like to express their profound gratitude to the Department of Zoology, Tri-Chandra Multiple Campus, for valuable suggestions and support during the completion of project work.

Authors Contributions

Rabina Pandey (RP) conducted research, gathered data, engaged in data analysis and interpretation, and wrote manuscript. Praveen Kumar Jha (PKJ) designed the study, suggested the framework for the project, assisted with data analysis and overall guidance. Aayusha Sharma Paudel (ASP) involved in data analysis and interpretation, manuscript writing and editing. The final manuscript was read and approved by all authors.

Abbreviations

BCN: Bird Conservation Nepal

DNPWC: Department of National Parks and Wildlife Conservation

IUCN: International Union for Conservation of Nature

NT: Near Threatened
LC: Least Concern
MS: Migratory Status
NS: National Status
GS: Global Status
RA: Relative Abundance

Ethical Approval

Bird diversity in the Chokchisapani Community Forest, Tanahu, Nepal was observed in the study. The ethical guidelines are strictly followed in the study for overall species observation & identification.

Informed Consent

Not applicable.

Conflicts of interests:

The authors declare that there are no conflicts of interests.

Funding:

The study has not received any external funding.

Data and materials availability

All data associated with this study are present in the paper.

Appendix 1 Checklist of birds recorded at the study area.

SN	Species	Scientific name	Family	Order	MS	NS	GS	RA
1	Black Francolin	<i>Francolinus francolinus</i> (Linnaeus, 1766)	Phasianidae	Galliformes	Resident	LC	LC	0.123
2	Red Junglefowl	<i>Gallus gallus</i> (Linnaeus, 1758)	Phasianidae	Galliformes	Resident	LC	LC	0.123
3	Kalij Pheasant	<i>Lophura leucomelanos</i> (Latham, 1790)	Phasianidae	Galliformes	Resident	LC	LC	0.371
4	Indian Pond-heron	<i>Ardeola grayii</i> (Sykes, 1832)	Ardeidae	Ciconiiformes	Resident	LC	LC	0.123
5	Black Kite	<i>Milvus migrans</i> (Boddaert, 1783)	Accipitridae	Falconiformes	Resident	LC	LC	1.734
6	Himalayan Buzzard	<i>Buteo refectus</i> (Portenko, 1929)	Accipitridae	Accipitriformes	Winter Visitor	LC	LC	0.247
7	Oriental Turtle-dove	<i>Streptopelia orientalis</i> (Latham, 1790)	Columbidae	Columbiformes	Resident	LC	LC	2.478
8	Ashy Woodpigeon	<i>Columba pulchricollis</i> (Blyth, 1846)	Columbidae	Columbiformes	Resident	LC	LC	29.244
9	Rose-ringed Parakeet	<i>Psittacula krameri</i> (Scopoli, 1769)	Psittacidae	Psittaciformes	Resident	LC	LC	0.743
10	Western Koel	<i>Eudynamys scolopaceus</i> (Linnaeus, 1758)	Cuculidae	Cuculiformes	Summer Visitor	LC	LC	0.247
11	Greater Coucal	<i>Centropus sinensis</i>	Cuculidae	Cuculiformes	Resident	LC	LC	0.991

		(Stephens, 1815)						
12	Common Cuckoo	<i>Cuculus canorus</i> (Linnaeus, 1758)	Cuculidae	Cuculiformes	Summer Visitor	LC	LC	0.247
13	Jungle Owlet	<i>Glaucidium radiatum</i> (Tickell, 1833)	Strigidae	Strigiformes	Resident	LC	LC	0.247
14	White-rumped Spinetail	<i>Zoonavena sylvatica</i> (Tickell, 1846)	Hemiprocnidae	Apodiformes	Resident	NT	LC	1.115
15	Himalayan Swiftlet	<i>Collocalia brevirostris</i> (Horsfield, 1840)	Apodidae	Apodiformes	Winter Visitor	LC	LC	1.61
16	Grey-headed Woodpecker	<i>Picus canus</i> (Gmelin, 1788)	Picidae	Piciformes	Resident	LC	LC	0.123
17	Greater Yellownappe	<i>Picus flavinucha</i> (Gould, 1834)	Picidae	Piciformes	Resident	LC	LC	0.123
18	Great barbet	<i>Megalaima virens</i> (Boddaert, 1783)	Megalaimidae	Piciformes	Resident	LC	LC	1.115
19	Black-winged Cuckooshrike	<i>Lalage melaschistos</i> (Hodgson, 1836)	Campephagidae	Passeriformes	Summer Visitor	LC	LC	0.123
20	Long-tailed Minivet	<i>Pericrocotus ethologus</i> (Bangs & Phillips, 1914)	Campephagidae	Passeriformes	Winter Visitor	LC	LC	0.991
21	Scarlet Minivet	<i>Pericrocotus flammeus</i> (Forster, 1781)	Campephagidae	Passeriformes	Resident	LC	LC	0.991
22	Long-tailed shrike	<i>Lanius schach</i> (Linnaeus, 1758)	Laniidae	Passeriformes	Resident	LC	LC	1.115
23	Grey-backed shrike	<i>Lanius tephronotus</i> (Vigors, 1831)	Laniidae	Passeriformes	Winter Visitor	LC	LC	0.247
24	Crow-billed Drongo	<i>Dicrurus annectens</i> (Hodgson, 1836)	Dicruridae	Passeriformes	Summer Visitor	LC	LC	0.247
25	Black Drongo	<i>Dicrurus macrocercus</i> (Vieillot, 1817)	Dicruridae	Passeriformes	Resident	LC	LC	1.115
26	Bronzed Drongo	<i>Dicrurus aeneus</i> (Vieillot, 1817)	Dicruridae	Passeriformes	Resident	LC	LC	1.239
27	Spangled Drongo	<i>Dicrurus hottentottus</i> (Linnaeus, 1766)	Dicruridae	Passeriformes	Resident	LC	LC	0.991
28	Yellow-bellied Fantail	<i>Rhipidura hypoxantha</i> (Blyth, 1843)	Rhipiduridae	Passeriformes	Winter Visitor	LC	LC	3.841
29	House Crow	<i>Corvus splendens</i> (Vieillot, 1817)	Corvidae	Passeriformes	Resident	LC	LC	0.991
30	Large-billed Crow	<i>Corvus macrorhynchos</i> (Wagler, 1827)	Corvidae	Passeriformes	Resident	LC	LC	2.973
31	Rufous Treepie	<i>Dendrocitta vagabunda</i> (Latham, 1790)	Corvidae	Passeriformes	Resident	LC	LC	0.867
32	Grey Treepie	<i>Dendrocitta formosae</i> (Swinhoe, 1863)	Corvidae	Passeriformes	Resident	LC	LC	13.011
33	Red-billed Blue Magpie	<i>Urocissa erythrorhyncha</i> (Boddaert, 1783)	Corvidae	Passeriformes	Resident	LC	LC	1.115
34	Common Green Magpie	<i>Cissa chinensis</i> (Boddaert, 1783)	Corvidae	Passeriformes	Resident	LC	LC	0.495

35	Cinereous Tit	<i>Parus cinereus</i>	Paridae	Passeriformes	Resident	LC	LC	1.239
36	Black-lored Tit	<i>Machlolophus xanthogenys</i> (Vigors, 1831)	Paridae	Passeriformes	Resident	LC	LC	1.982
37	Zitting Cisticola	<i>Cisticola juncidis</i> (Rafinesque, 1810)	Cisticolidae	Passeriformes	Resident	LC	LC	0.867
38	Grey-breasted Prinia	<i>Prinia hodgsonii</i> (Blyth, 1844)	Cisticolidae	Passeriformes	Resident	LC	LC	0.123
39	Red-vented Bulbul	<i>Pycnonotus cafer</i> (Linnaeus, 1766)	Pycnonotidae	Passeriformes	Resident	LC	LC	3.097
40	Himalyan Bulbul	<i>Pycnonotus leucogenys</i> (Gray, 1835)	Pycnonotidae	Passeriformes	Resident	LC	LC	2.23
41	Buff-barred Warbler	<i>Phylloscopus pulcher</i> (Blyth, 1845)	Phylloscopidae	Passeriformes	Winter Visitor	LC	LC	0.743
42	Whistler's Warbler	<i>Phylloscopus whistleri</i> (Ticehurst, 1925)	Phylloscopidae	Passeriformes	Winter Visitor	LC	LC	0.495
43	Grey-hooded Warbler	<i>Phylloscopus xanthoschistos</i> (Gray, 1846)	Sylviidae	Passeriformes	Resident	LC	LC	4.708
44	White-crested laughingthrush	<i>Garrulax leucolophus</i> (Hardwicke, 1815)	Timaliidae	Passeriformes	Resident	LC	LC	0.743
45	White-browed Scimitar-babbler	<i>Pomatorhinus schisticeps</i> (Hodgson, 1836)	Timaliidae	Passeriformes	Resident	NT	LC	0.743
47	Blue Whistling-thrush	<i>Myophonus caeruleus</i> (Scopoli, 1786)	Muscicapidae	Passeriformes	Resident	LC	LC	0.991
48	Oriental Magpie-robin	<i>Copsycus saularis</i> (Linnaeus, 1758)	Muscicapidae	Passeriformes	Resident	LC	LC	0.619
49	Chestnut-bellied Rock-thrush	<i>Monticola rufiventris</i> (Jardine & Selby, 1833)	Muscicapidae	Passeriformes	Resident	LC	LC	0.371
50	Rufous-gorgeted Flycatcher	<i>Ficedula strophiatea</i> (Hodgson, 1837)	Muscicapidae	Passeriformes	Winter Visitor	LC	LC	0.743
51	Little Pied Flycatcher	<i>Ficedula westermanni</i> (Sharpe, 1888)	Muscicapidae	Passeriformes	Winter Visitor	LC	LC	0.123
52	Grey Bushchat	<i>Saxicola ferreus</i> (Gray, 1846)	Muscicapidae	Passeriformes	Resident	LC	LC	0.247
53	Small Niltava	<i>Niltava macgrigoriae</i> (E. Burton, 1836)	Muscicapidae	Passeriformes	Resident	LC	LC	0.247
54	Grey-headed Canary-flycatcher	<i>Culicicapa ceylonensis</i> (Swainson, 1820)	Stenostiridae	Passeriformes	Winter Visitor	LC	LC	0.495
55	Crimson Sunbird	<i>Aethopyga sipraja</i> (Raffles, 1822)	Nectariniidae	Passeriformes	Resident	LC	LC	0.495
56	White-rumped Munia	<i>Lonchura striata</i> (Linnaeus, 1766)	Estrildidae	Passeriformes	Resident	LC	LC	2.106
57	Grey Wagtail	<i>Motacilla cinerea</i> (Tunstall, 1771)	Motacillidae	Passeriformes	Winter Visitor	LC	LC	0.123
58	Olive-backed Pipit	<i>Anthus hodgsoni</i> (Richmond, 1907)	Motacillidae	Passeriformes	Winter Visitor	LC	LC	0.991

59	Russet Sparrow	<i>Passer rutilans</i> (Temminck, 1836)	Paseridae	Passeriformes	Resident	LC	LC	1.858
----	----------------	--	-----------	---------------	----------	----	----	-------

REFERENCES

1. Barzan FR, Bellis LM, Canavelli SB, Calamari NC, Dardanelli S. Bird functional and taxonomic diversity in xerophytic forests: contributing to balance bird conservation and livestock production. *Agric Ecosyst Environ* 2023; 355(1):1085-88. doi: 10.1016/j.agee.2023.108588

2. Bishnu BKC, Mandal RA, Sumitra KC. Assessment of Sustainability in Community Forests: A Study from Dolakha District, Nepal. *Int J For Res* 2023; 2023:13. doi: 10.1155/2023/8657985

3. Gibson L, Lee TM, Koh LP, Brook BW, Gardner TA, Barlow J, Peres CA, Bradshaw CJ, Laurance WF, Lovejoy TE, Sodhi NS. Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature* 2011; 478(7369):378-81. doi: 10.1038/nature10425

4. Graham V, Nurhidayah L, Astuti R. Reducing emissions from tropical deforestation and forest degradation. In DA DellaSala, DA DiPaolo (Eds.), *Encyclopedia of the world's biomes* 2020; 3:260-268. Elsevier. doi: 10.1016/B978-0-12-409548-9.11928-1

5. Grimmett R, Inskipp C, Inskipp T, Baral HS. *Birds of Nepal: A field guide*, Second edition. Christopher Helm: London, UK, 2016.

6. Gumede ST, Smith DAE, Smith YCE, Ngcobo SP, Sosibo MT, Maseko MST, Downs CT. Occupancy of two forest specialist birds in the Southern Mistbelt forests of KwaZulu-Natal and Eastern Cape, South Africa. *Bird Conserv Int* 2022; 32:27-42. doi: 10.1017/S0959270920000544

7. Hollie DR, George AD, Porneluzi PA, Haslerig JM, Faaborg J. Avian community response to experimental forest management. *Ecosphere* 2020; 11(11):e03294. doi: 10.1002/ecs2.3294

8. Jha PK. Diversity of birds in the foothills of Phulchoki hill, Lalitpur, Nepal. *Forestry: J Inst For, Nepal* 2019; 16:62-71. doi: 10.3126/forestry.v16i0.2835

9. Jha PK. Status of migratory birds in Nepal. *J UGC* 2016; 5(1):67-77.

10. Leitão PJ, Toraño CA, Dahlkamp A, Guderjan L, Griesser M, Haverkamp PJ, Nordén J, Snäll T, Schröder B. Impacts of forest management on forest bird occurrence patterns—a case study in Central Europe. *Front For Glob Change* 2022; 5:786556. doi: 10.3389/ffgc.2022.786556

11. Neupane B, Dhami B, Panthee S, Stewart AB, Silwal T, Katuwal HB. Forest Management Practice Influences Bird Diversity in the Mid-Hills of Nepal. *Animals (Basel)* 2022; 12(19):2681. doi: 10.3390/ani12192681

12. Ramírez-Soto A, Rodríguez-Mesa R, Villa-Bonilla B, Sheseña-Hernández I, Inzunza ER. Using birds to assess and track forest restoration. *Trop Conserv Sci* 2018; 11:1-6. doi: 10.1177/1940082918780359

13. Shannon CE, Weaver W. *The Mathematical Theory of Communication* Urbana, IL: The University of Illinois Press, 1949; 1-117.

14. Simpson EH. Measurement of diversity. *Nature* 1949; 163(4148):688. doi: 10.1038/163688a0

15. Stratford JA, Şekercioğlu ÇH. Birds in forest ecosystems. In *Routledge handbook of forest ecology*, 2015; 279-294.

16. Sutherland WJ. *Ecological census techniques: a handbook*. 2nd Edition, Cambridge University Press, Cambridge, UK, 2006.